

Nanocomposite Magnets

presented by

Sam Bader

DOE Center of Excellence for
Synthesis and Processing

Annual Meeting

DOE, Germantown, MD
Friday, June 4, 2004

Isolated and Collective Phenomena in Nanocomposite Magnets

- Ames Bill McCallum • LBNL Jeff Kortright
- Matt Kramer
- Bruce Harmon • UW-Seattle Kannan Krishnan
- Vladimir Antropov

- ANL Sam Bader • LLNL Jim Tobin
- J. Samuel Jiang

- BNL Laura Henderson Lewis • LANL Marilyn Hawley
- David Welch

- UI/MRL Robert Averback • ORNL Thomas Schultheiss
- Pascal Bellon
- Myron Salamon • SNL/NM Malcolm Stocks

- James Martin

DOE CSP Nanocomposite Magnetic Materials
2003 Annual Workshop
Asilomar Conference Center Pacific Grove, California
October 19-21, 2003

Sunday evening session

8:00 – 8:10 p.m.	Welcome Jeff Kortright and Sam Bader Exchange Coupling (Dolphin Room) Jeffrey Kortright, Chair	Dolphin Room
8:10 – 8:30 p.m.	Eric Fullerton, <i>Hitachi Global Storage Technologies</i> “AF coupled perpendicular anisotropy films”	$KV \gg k_B T$
8:30 – 8:50 p.m.	Samuel Jiang, <i>Argonne National Laboratory</i> “Determination of Fe spin spiral structure in Fe/Sm-Co exchange spring bilayers”	
8:50 – 9:10 p.m.	Laura Henderson Lewis, <i>Brookhaven National Laboratory</i> “Interphase exchange effects in CoPt/Co bilayer thin films”	
9:10 – 9:30 p.m.	William McCallum, <i>Ames Laboratory</i> “The origin of hysteresis in recoil loops of exchange enhanced perm. magnets”	
9:30 – 9:50 p.m.	Suzanne te Velthuis, <i>Argonne National Laboratory</i> “Domain states during magnetic reversal of exchange biased Co/CoO bilayers”	 The IPNS logo is a blue starburst shape containing the letters "IPNS".

Monday, 20 October 2003

Nanostructures in the Recording Industry (Dolphin Room)
Axel Hoffmann, Chair

- 8:30 – 8:50 a.m. **Andreas Berger, Hitachi Global Storage Technologies**
“Materials issues and challenges in magnetic recording disk technology”
- 8:50 – 9:10 a.m. **Bruce Terris, Hitachi Global Storage Technologies**
“Nanomagnets for data storage”
- 9:10 – 9:30 a.m. **Stefan Maat, Hitachi Global Storage Technologies**
“Magnetic recording read heads: An example of applied nano-structures”
- 9:30 – 9:50 a.m. **Marilyn Hawley, Los Alamos National Laboratory**
“MFM imaging of a magnetic multilayer and CMR thin film”
- 10:20 – 10:40 a.m. **Matthew Kramer, Ames Laboratory**
“Spontaneous magnetostriction in $R_2Fe_{14}B$ (R=Y, Nd, Gd, Tb, Er)”
- 10:40 – 11:00 a.m. **Daniel Haskel, Argonne National Laboratory**
“Beyond element-specific magnetism in $Nd_2Fe_{14}B$ permanent magnet”
- 11:00 – 11:20 a.m. **Vladimir Antropov, Ames Laboratory**
“Magnetic short-range order effects in itinerant magnets”
- 11:20 – 11:40 a.m. **Hal Lee, Oak Ridge National Laboratory**
“Using polarized neutrons to study micro- to nano-magnetic surface structures”
- 11:40 – 12:00 p.m. **Sam Bader, Argonne National Laboratory**
CSP Nanomag – History & Future, Discussion



Tuesday 21 October 2003

Nanoparticles

Eric Fullerton, Chair

8:30 – 8:50 a.m.	Shouheng Sun, IBM Watson Research Center “Nanoparticle based exchange spring nanocomposites”
8:50 – 9:10 a.m.	Pascal Bellon, University of Illinois, Urbana-Champaign “Synthesis and characterization of magnetic nanoclusters and nanoprecipitates”
9:10 – 9:30 a.m.	Kannan Krishnan, University of Washington, Seattle “Self assembly & direct imaging of mag. interactions in nanoarrays of Co spheres and disks”
9:30 – 9:50	Jeffrey Kortright, Lawrence Berkeley National Laboratory “Interparticle magnetic correlations in self-assembled Co nanoparticles”
10:20 – 10:40 a.m.	Seth Darling, Argonne National Laboratory “Lithographically assisted hierarchical self-assembly of magnetic nanostructures”
10:40 – 11:00 a.m.	Andreas Scholl, Lawrence Berkeley National Laboratory “X-ray Imaging of Magnetization and Spin Dynamics”
11:00 – 11:20 a.m.	Valentyn Novosad, Argonne National Laboratory “Spin excitations in patterned dot arrays with magnetic vortex ground state”
11:20 – 11:40 a.m.	James Tobin, Lawrence Livermore National Laboratory “First spin-resolved photo-emission spectroscopy results from the APS at ANL”
11:40 – 12:00 p.m.	Thomas Schultheiss, Oak Ridge National Laboratory “Valency and exchange of Mn impurities in III-V semiconductors”



Adjourn

Magnetism Programs & Prospects at DOE Nano Science Research Centers

Sam Bader, Chair

8:30 – 10:00 p.m. Axel Hoffmann

Argonne National Laboratory

Laura Henderson Lewis

Brookhaven National Laboratory

Thomas Schulthess

Oak Ridge National Laboratory

Marilyn Hawley

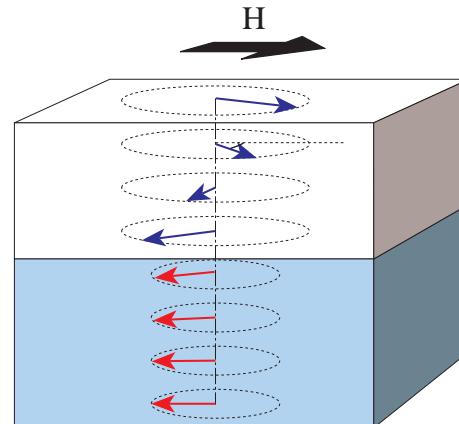
Los Alamos National Laboratory

Jeffrey Kortright

Lawrence Berkeley National Laboratory

Annual Progress

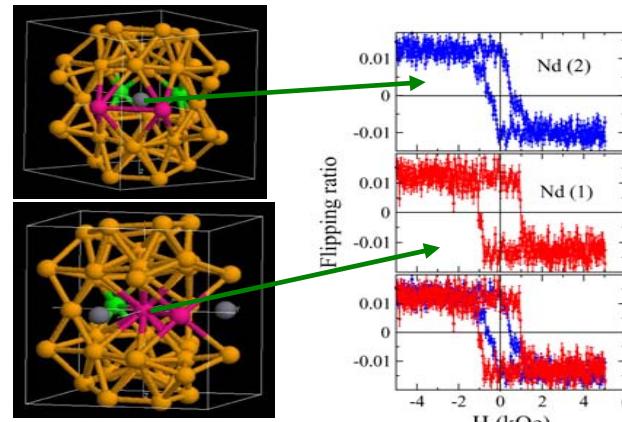
- Compounds
- Interfaces
- Interacting Particles



Compounds

$\text{Nd}_2\text{Fe}_{14}\text{B}$ permanent magnet

Use two diffracting conditions to separate Nd(1) and Nd(2) magnetic sites

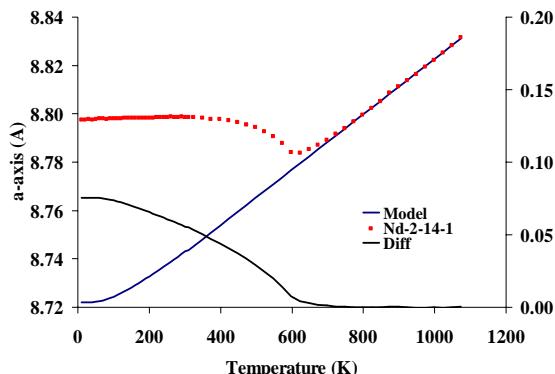


XMCD at APS
using Nd L_2 edge

D. Haskel (ANL/APS)

P. Canfield (Ames)

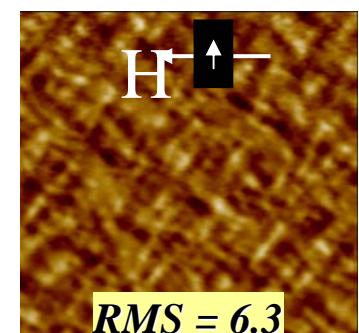
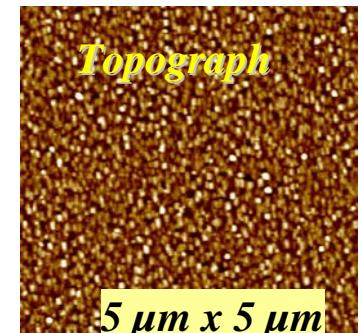
$\text{R}_2\text{Fe}_{14}\text{B}$ Magnetostriction



Diffraction at APS

Matthew J. Kramer, Ning Yang, Kevin Dennins,
and Bill McCallum (Ames)
Y. Zhang and P. L. Lee (APS/ANL)
David Welch, (BNL)

SmCo Film

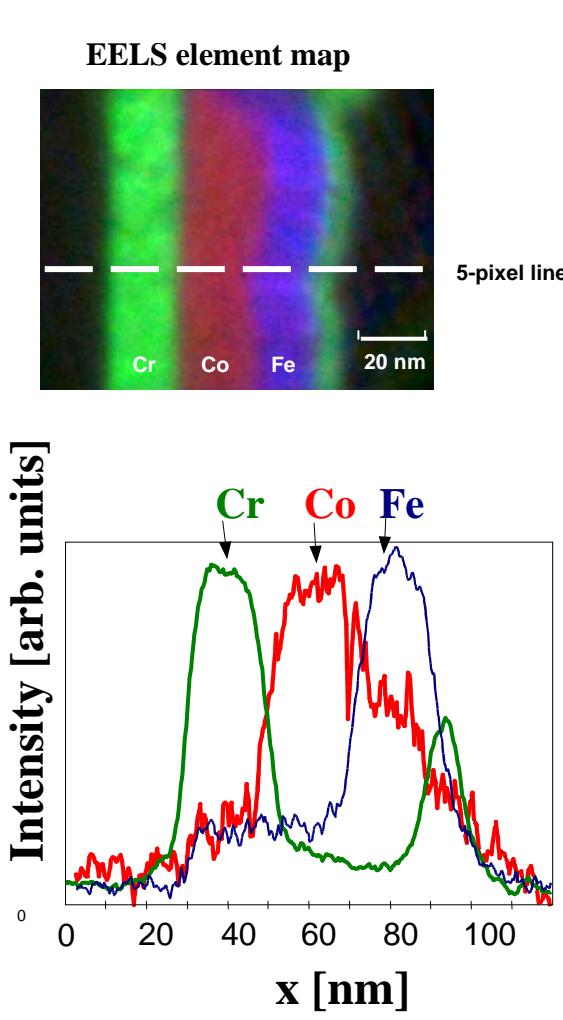


Cr/SmCo/Cr/MgO(110)
MFM in field

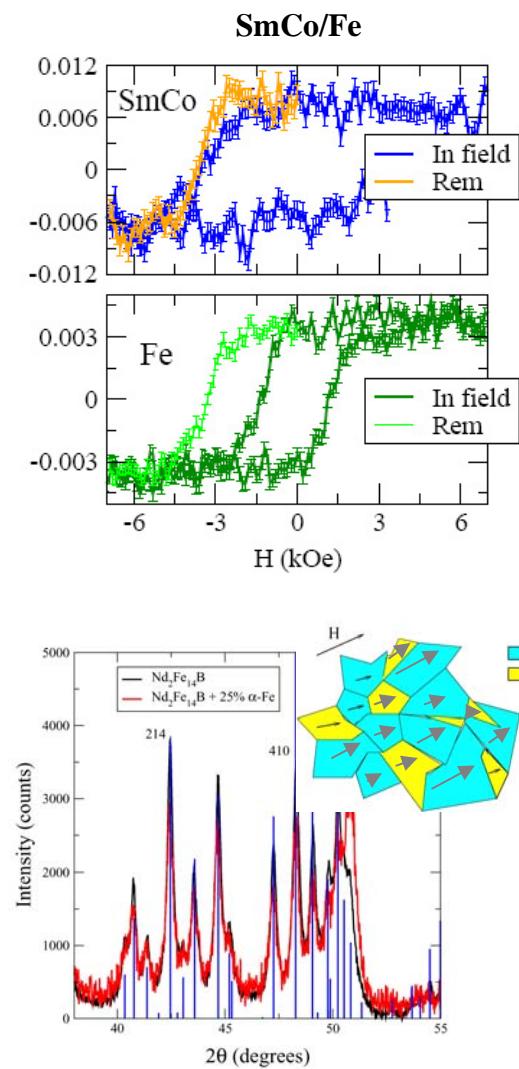
M. Hawley (LANL)

S. Jiang (ANL)

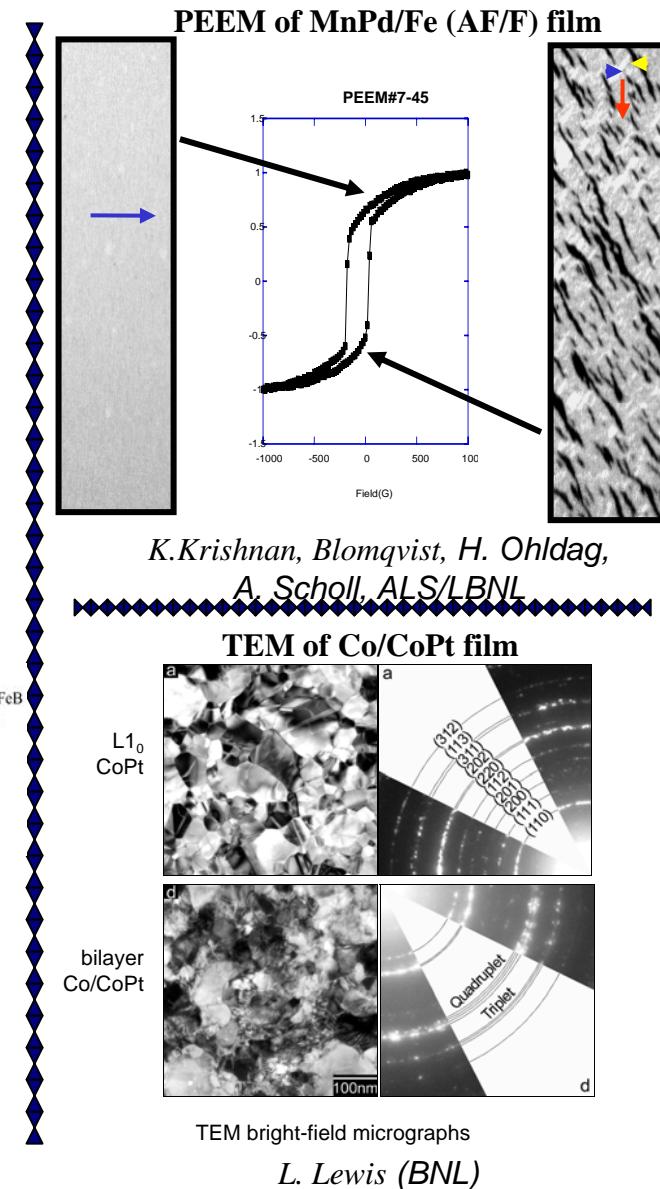
Interfaces



J. S. Jiang, J. E. Pearson, S. D. Bader,
D. R. Lee, D. Haskel, G. Srivastava, Z. Liu,
B. Kabius, D. J. Miller (ANL)

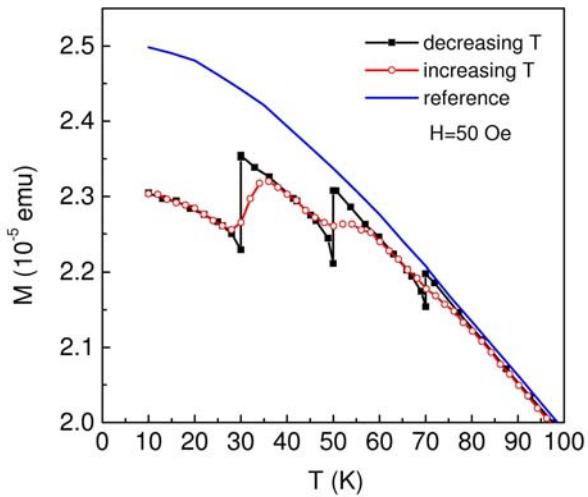


D. Haskel (APS/ANL), B.-M. Ma (MQI)

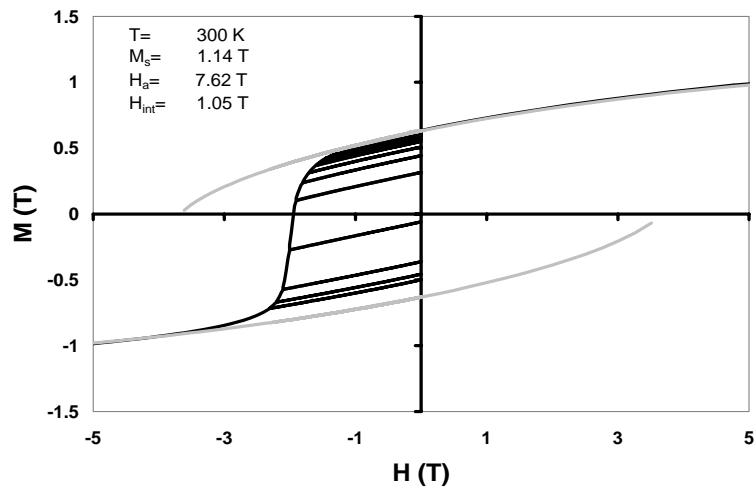


Interacting Particles - I

Memory Effect: Py nanoparticles



Nanocrystalline Hard Magnets



Hierarchical Energy Landscapes

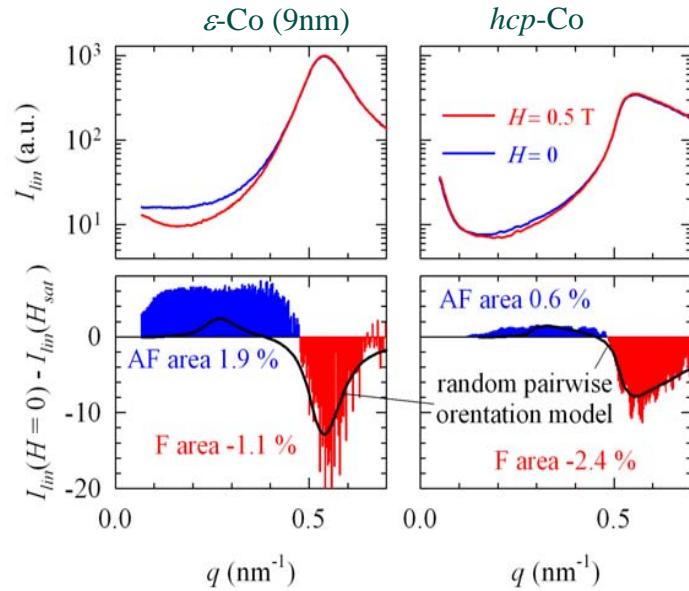
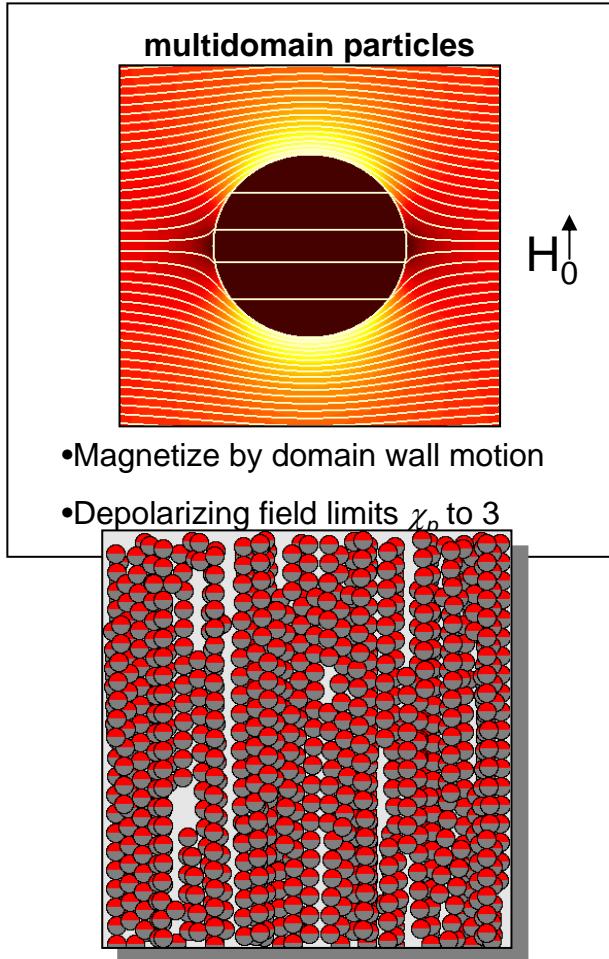
Myron B. Salamon, P. Bellon,
R. Averback (UIUC)

Mean field model

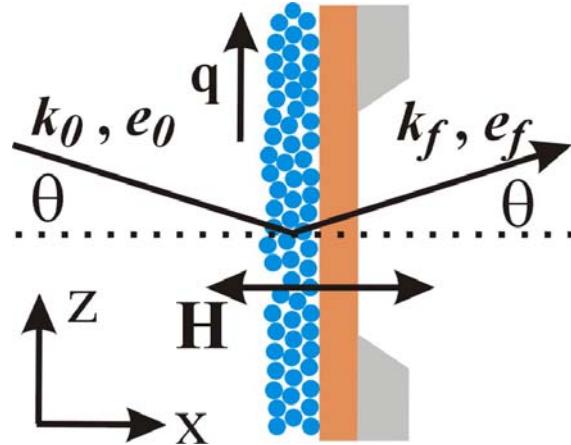
R. W. McCallum and M. J. Kramer (Ames),
L. H. Lewis (BNL), B.-M. Ma (MQI),
J. E. Shield (U Neb)

Interacting Particles - II

Susceptibility Enhancement in Structured Nanocomposites

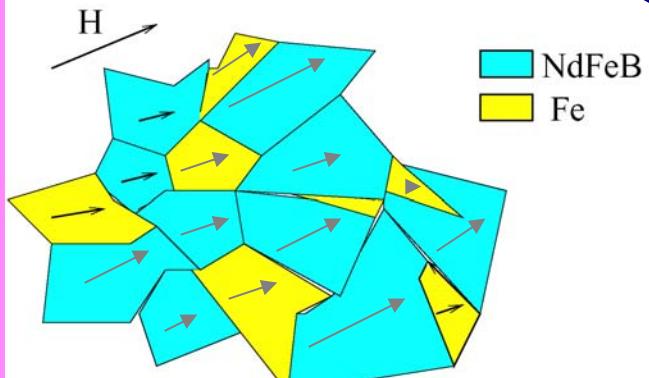


Difference in remanent magnetic scattering between samples implies strong influence of dipolar interactions



Overview

Tailored Permanent Magnets



ANL



BNL



LBNL

NSRC's



ORNL



LANL/SNL

Self Assembly

